Aalto-yliopisto
Insinööritieteiden
korkeakoulu

L0: Course Info

MEC-E1030 Random Loads and Processes
Date: 05.09.2023

Responsible teacher information

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TA information

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Learning Objectives of the Course

The aim of the course is to

- Introduce the student to theoretical treatment of random (stochastic) processes such as loads due to wave and wind on structures.
- Give the student the basic knowledge of probability concepts and how these are applied in mechanics
- Give information of the random variables and how various probability distributions are connected
- Give tools to apply time-domain measurements and convert them to frequency domain and to define load spectrum in (spectral analysis)
- Give methods to estimate the probability of exceedance of certain load from the load spectrum (extreme values for ultimate strength and cumulative damage for fatigue assessment).

Important Related Courses

- Probability theory
- Mechanics of rigid body
- Fourier analysis (time vs. frequency domain)
- Complex numbers
- Let me know: https://presemo.aalto.fi/rlday1

We aim to communicate the issues in easy manner!

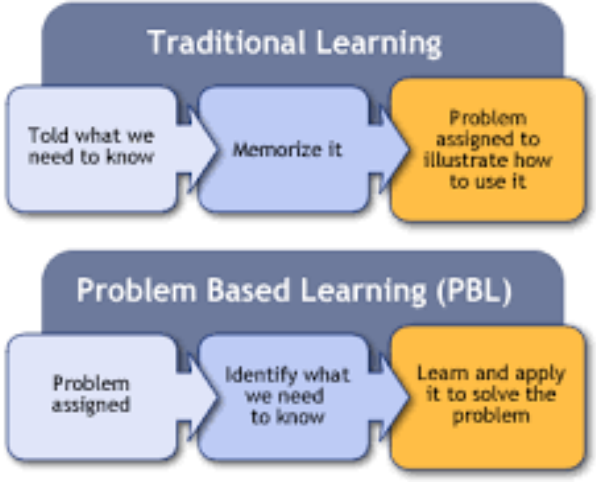
Cumulative Learning on the Course

Week	Topic 1	Topic 2	Contribution to big picture
1	Design Process with Focus on Mission Definition	Probability concepts and distributions	To understand the basic concepts needed in treatment of random loads and processes. General description of random variables and their properties. Discrete and continuous probability distributions. Definition of the random process in your engineering project.
2	Transient and steady state process	Moving from time to frequency domain (FFT) & vice versa (IFFT)	General description of random vibration and it's stages for single degree of freedom system for single frequency in time and frequency domains. Extension to multiple frequencies and superposition to create random signal. Fast Fourier Transform and it's inverse.
3	Environmental loads and load spectra	Response spectrum	To identify the kind of environmental loads relevant to your engineering project and how they form. The selection of proper load spectra for design. Computation of responses based load spectra and Response Amplitude Operator (RAO). Methods to determine RAO.
4	Direct, numerical, extraction of elevation probabilities from random signal	Direct, numerical, extraction of peak-to-peak probabilities from random signal	Numerical methods to extract probability of certain elevation and peak-to-peak values from random signal
5	Short-term assessment for ultimate limit state	Long-term assessment for fatigue limit state	Application of random process theory for short-term prediction relevant for ultimate strength assessment and long-term prediction for cumulative fatigue damage.
6	Spectral moments for displacements, velocities and accelerations		Introduction to spectral moments and how they can be used to directly calculate probability distributions from spectra
7	Exam reviewing the learned contents		

Methods and Work Load

- The course utilizes problem-based-learning concept

- **Each week:**
  - We define a subtask to be solved
  - Lectures are given (live / on-line)
  - **The student groups (3-5 persons)** solves the weekly assignment
  - We discuss the issues in the Q&A session
  - Groups return a written report
  - The weekly submissions will be graded from 1-5 and feedback on how to increase the grade
  - Within one week you may submit the corrected report which forms the final assignment grade



- **Some problems are open-ended**
- **Effective group work is essential**

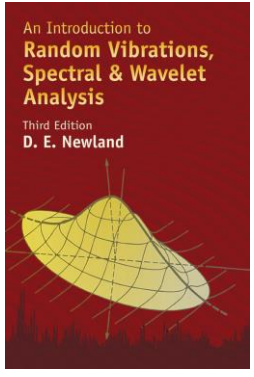
MATLAB is the primary tool – use your resources

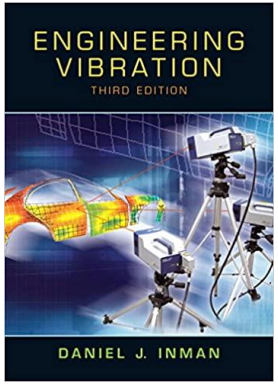
Methods and Work Load

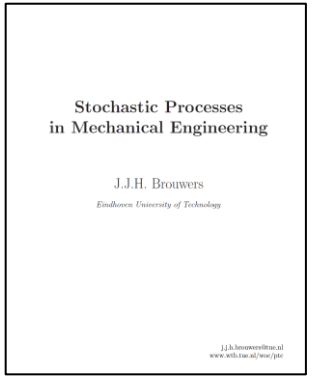
- **Grading**
  - The weekly submissions will contribute 50% to the course grade
  - The remaining 50% of the grade is defined by the final exam **or** a learning diary (Please see more details on the **mycourses page**)

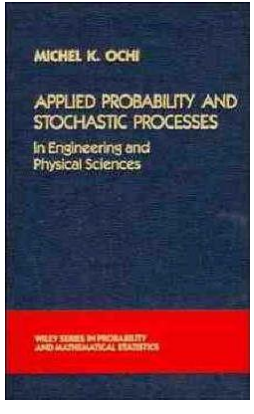
- **Work load**
  - Lectures: 24h (6 x 2 x 2h/week)
  - Home assignments: 50h (5 x 10h/week)
  - Studying materials: 50h (5 x 10h/week)*
  - Preparing for exam: 10 h*
  - * A learning diary should easily fit in these 60 hours. If possible, take the advantage of getting one sample evaluated before final submission.

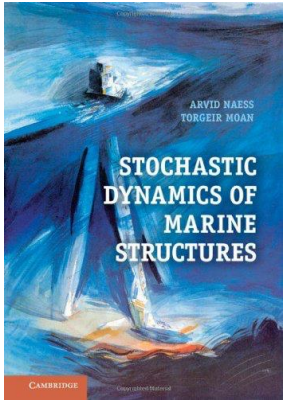
Resources

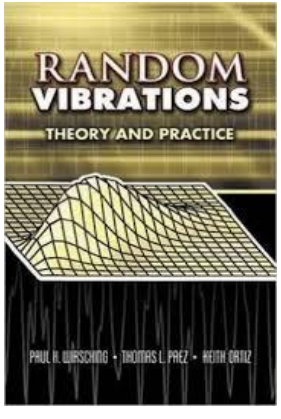


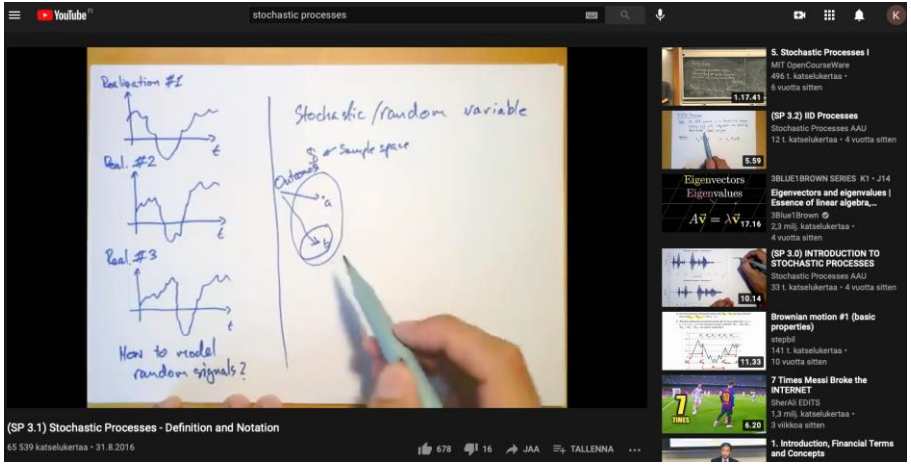












- **Articles relevant to your own engineering problem**